

after the method of Kocher, and silk after that of Czerny, represented the materials used for sutures.

The dressings in common use did not prove to be of practical value here. After closure of the abdominal wound, which was done by the combined "mattress suture" and "glover's stitch," it was dusted with iodoform and a liberal application of liq. gutta percha used as the only dressing. The liq. gutta percha when made by reinforcing the U. S. P. preparation, with an additional one-third of its official amount of gutta percha furnished an admirable dressing, sealing the wound in a most thorough manner. As to the food, this in the beginning, for about a week subsequent to the operation, was restricted to that of a liquid character, but later such care was less and less observed, until finally almost ignored, and in one instance where a resection was done, by a mistake a large piece of raw meat was given but a few hours after the operation without any evil resulting. Such briefly represents the manner in which the experiments were carried on. Neither time nor space would permit here of even a brief review of the opinions and progress of the work done upon this subject.

#### SOME GENERAL CONSIDERATIONS OF THE NATURE OF THESE INJURIES.

Nowhere within the domain of surgery are the effects attending gunshot wounds more multiple and uncertain in their nature than those penetrating the abdominal cavity.

Even where some definite knowledge of the character of weapon and missile used and the circumstances under which the injuries were received are at hand, no safe conclusions can be reached as to the extent and course of the ball or the amount and character of damage it creates, since it is a well-known fact that even where projectiles are discharged under conditions as like as practicable, they will often differ widely in their energy and velocity. While it may be safely said that as a rule the extent of danger is more or less in direct ratio to the size of the ball, such a rule is by no means absolute. Numerous conditions, some of which apparently trivial in their

nature, have a marked influence upon the effect of the missiles. To a certain extent this was discernable in these experiments where floberts, .22 "shorts" and "longs" were differently employed. Notwithstanding the latter and regardless of the weapon, there was apparently no difference in the number of perforations whether the one or the other was employed. Such however was not the case as regards the nature of the injury. Here a certain relation was traceable between the character of the missile and weapon upon one hand and that of the injury upon the other. Especially was such the case



FIG. 1.—SHOWING A PERFORATION CREATED BY A .22 CALIBRE BALL FIRED FROM A REMINGTON RIFLE.

where the rifle was employed, the effect of which was in nearly every perforation markedly out of proportion to the size of the ball. Figs. 1 and 2, each of which measured more than an inch in length and nearly the same in width. The diverse effects of missiles are generally explained upon the differences in their energy and velocity, together with a rotatory motion which they acquire after a certain part of their course. Where the disproportion between the effect and the size of the missile is

very great the difference seems to point largely to the latter as the cause. With the exception of two, every ball fairly entered the abdominal cavity and many passed through making their exit upon the opposite side. Of the two that failed to enter one became arrested immediately under the parietal peritoneum while the other fell harmlessly aside without even producing a lesion in the skin.



FIG 2.—SHOWING ANOTHER PERFORATION CREATED BY A .22 CALIBRE BALL FIRED FROM A REMINGTON RIFLE.

In forty experiments upon thirty-six alive and four just dead from the effects of the anæsthetic, where it was positively known that the ball had entered the abdominal cavity, one escaped without receiving any injury whatever to the contained viscera, in another the damage amounted to a non-perforating wound of the intestine and a wound of the mesocolon involving a large vessel, in a third to that of a non-perforating wound of the intestine and in a fourth to a wound of the spleen without any intestinal lesion. That balls may pass through the abdominal cavity in the human, without producing an in-

jury to any of the contained viscera, is mentioned by different authors; and while there remains no doubt of the possibility of such, experience has abundantly proven that it is by far the exception and we may safely conclude that when a ball has entered the abdominal cavity that injury to one or more viscera has occurred. And when we consider the anatomical arrangement of the contained viscera it is not difficult to see why such should almost inevitably be the case and only where the path of the ball is superficial or tangent to the abdominal wall does escape at all seem possible.

Following the perforation of the intestine generally occurs an ectropion of the mucosa which as a rule corresponds in degree to the size of the opening.

Notwithstanding the great uncertainty of the wound of entrance as a guide to the injury within, a study of the same should not be overlooked, since it not only furnishes inferences of the probable injury but is often of value to the surgeon as an aid in more readily determining the source of the severe hæmorrhage.

The opinion among surgeons seems to differ upon the relative frequency with which extravasation complicates perforations of the stomach and intestines. By many it is held that such is the rule, while the experiments differently made upon lower animals decidedly point to the contrary, and also in the human subject the cases are not sparing where not only large as well as multiple openings existed without any extravasation occurring and in spite of the fact that the bowel contained much feculent matter. It is the opinion of Sir William MacCormac<sup>1</sup> that experience teaches that fæcal extravasation follows in ninety-nine out of every one hundred intra abdominal injuries, but no mention is made of the time that passes before the escape, and Otis, in the "Medical and Surgical History of the Rebellion," expresses a like opinion that in the vast majority of cases extravasation follows. It is to be regretted that in the cases so far reported very little is mentioned of this as a complication to the injury, since it is only by a study of a large number of cases that this question can

<sup>1</sup>Klin. Zeit. und Streitfragen, p. 357, bd. 2, hft. 10.

be satisfactorily answered. In thirty-two of the containing experiments nineteen were attended with extravasation and of this number it was the exception for such to occur before handling of the intestine was commenced. Erichsen assigns three principal causes that tend to prevent extravasation: (a) Ectropion of the mucosa. (b) Closure of the opening by the contiguous coils of intestines. (c) Arrest of the peristalsis from the shock of the injury.

In the experimental work it was not an uncommon occurrence to notice a perceptible impression upon the animal immediately after the reception of the injury. Occasionally the intestines were found almost throughout in a state of contraction or in portions alternately contracted and dilated and where this contraction existed it never failed to undergo relaxation upon exposure and handling. In the absence of interference, that extravasation should be the ultimate outcome of perforations of the intestines is not difficult to see, yet there is no doubt that a large number of the cases that fall into the hands of the surgeon during the first twelve hours are devoid of this complication and the chances of immunity increases with the promptness of the interference and the enjoining of absolute quiet on the part of the patient.

Based upon an analysis of 253,142 cases of shot injuries occurring in the late war, Otis<sup>1</sup> placed the frequency of those occurring in the abdominal region at 3.3%, or one in twenty-nine. The following aggregate of 1,072 cases of known injury to the abdominal viscera represents the relative frequency with which the different viscera were injured.

| <i>Wounds.</i>                        | <i>Cases.</i> | <i>Ratio of Mortality of<br/>Determined Cases.</i> |
|---------------------------------------|---------------|----------------------------------------------------|
| Intestines, - - - - -                 | 653           | 80.3                                               |
| Liver, - - - - -                      | 173           | 63.5                                               |
| Stomach, - - - - -                    | 79            | 75.9                                               |
| Kidney, - - - - -                     | 78            | 66.2                                               |
| Blood Vessels, Omentum and Mesentery, | 54            | 87.                                                |
| Spleen, - - - - -                     | 29            | 93.1                                               |
| Suprarenal Capsule, - - - - -         | 1             | 100.                                               |
| Pancreas, - - - - -                   | 5             | 80.                                                |
| Total, - - - - -                      | 1,082         |                                                    |

<sup>1</sup>Med. and Surg. History of War of Rebellion, 2d Surg. Vol.

While the table prepared by Otis from which the above is an extract may in certain particulars be doubtful, it gives at least an approximative idea of the relative frequency with which the different organs are injured and from the above it is apparent that the chances of injury to any certain organ increases with its size and superficial location.

Intestinal injuries involving the mesenteric border are often attended with profuse hæmorrhage, the same is true of wounds of the stomach near the curvature.

Wounds of the spleen and liver are always attended with hæmorrhage and where the injuries are severe there is danger from this source of death primarily, and in addition to this in the latter organ authors lay great stress upon the irritating effects of the bile upon the peritoneum. Such, however, was not the experience in these experiments and it is mentioned in the history of the civil war that the experiments upon lower animals by Höring, Herlin and Campaignac indicate that the irritating action of bile upon the peritoneum is overrated, and that some of the facts observed during the war point in the same direction.

Wounds of the pancreas are generally above the others in gravity because of its deep location and the close relation to important vessels. Injuries of the omentum and mesentery are regarded as serious only when they are attended with hæmorrhage. Of the solid viscera mentioned in the experiments the spleen was wounded in nearly half. This was partly due to the transverse direction of the balls, but principally to a very much enlarged condition of this organ that was not uncommonly met with in these animals.

In a series of five experiments the "do-nothing" plan was carried out with a view of studying nature's method of repairing these injuries. Of these four resulted in death, and the fifth made his escape in a week's time in a condition which left no doubt of his recovery. However, in this case the course of the ball was so superficial, and the resulting effects so slight, that it is believed that the ball either failed to enter the abdominal cavity, or if it did so, its course was such a superficial one as to pass above the contents.

Observations, experimental and otherwise, lead to the belief that where unaided repair results, nature effects this in some of the following ways: (*a*) Closure of the perforation by an adhesion to a neighboring coil. (*b*) An omental adhesion. (*c*) By an adhesion to the abdominal wall. (*d*) Only where the opening is minute by an exudate of plastic lymph. In the experiments terminating in recovery, subsequent examination showed that peritonitis had occurred in nearly all. Generally this was circumscribed, but in a few it extended over the whole peritoneum, and in one the adhesions were so extensive that the whole of the intestines were adherent in one solid mass, and were so removed. Notwithstanding the recent deformity that followed the closure of intestinal wounds, permanent coarctation was rarely observed, and then only in a slight degree.

#### SYMPTOMS, DIAGNOSIS AND PROGNOSIS.

As for the symptoms, they may be conveniently divided into the primary, or those referable to the injury itself, and the secondary, or those referable to the complications consecutive to the injury. The symptoms of the first class can be mentioned as those relative to the constitution at large and those of a local nature.

The constitutional symptoms here are the well known symptoms of shock, the same as the symptoms of severe injuries elsewhere. Although shock, in a more or less degree, is a common attendant upon these injuries, its absence, even in severe cases, is not infrequent, and it has been noted that in many cases there exists a marked disproportion between the injury and the shock. Even when attended with severe hæmorrhage, there may be a comparative absence of the symptoms relative to the same, an example of which occurred under the observation of the writer during a service as interne at the Louisville City Hospital.

An athletic negro, of apparently 20 years, was found reclining upon a porch, talking to his friends in a very rational manner, with little or no evidence of severe injury. Subsequently upon arrival at the hos-